

AMENDMENTS TO THE CLAIMS:

Please cancel claims 49-51, 53-54, and 73-75, without prejudice. Claims 1-48, 52, 55, and 57-72 were previously canceled.

Please add new claims 76-187 as indicated below in the listing of claims which will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1 – 55 (Canceled).

56. (Previously presented) A method for passively monitoring physiology of a patient, the method comprising:

engaging a first piezoelectric sensor with the patient by coupling the patient with a patient supporting surface including the first sensor;

engaging a second piezoelectric sensor in a location for sensing environmental noise, but not physiological signals from the patient;

engaging a third piezoelectric sensor with the patient, at a location remote from the first sensor;

sensing physiological signals and environmental noise with the first and third sensors and environmental noise with the second sensor;

isolating the physiological signals from the environmental noise by subtracting environmental noise sensed by the second sensor from the signals sensed by the first and third sensors;

comparing the physiological signals and environmental noise from the first sensor with the physiological signals and environmental noise from the third sensor to determine locations of the first and third sensors on the patient; and  
displaying the physiological digital signals.

57 – 75 (Canceled)

76. (New) A method for passively monitoring the physiology of a patient in a vibration environment, comprising:

coupling a sensor with the patient, the sensor comprising a polarized polymer film with piezoelectric properties;

sensing mechanical activity of the patient with the sensor, including activity associated with the physiology of the patient and activity caused by the vibration environment;

converting the sensed mechanical activity into signals;

extracting signals corresponding to the physiology of the patient;

separating signals associated with a selected physiological parameter of the patient; and

outputting a signal representative of the selected physiological parameter of the patient.

77. (New) The method of claim 76, wherein the sensor comprises a polyvinylidene fluoride (PVDF) film.

78. (New) The method of claim 76, wherein the vibration environment comprises a medical transport.

79. (New) The method of claim 76, wherein the vibration environment comprises a helicopter.

80. (New) The method of claim 79, wherein the selected physiological parameter is selected from the group consisting of respiratory rate and pulse rate.

81. (New) The method of claim 76, wherein the vibration environment comprises an ambulance.

82. (New) The method of claim 76, wherein the sensor is disposed along a patient supporting surface.

83. (New) The method of claim 76, wherein the sensor is placed on the patient.

84. (New) The method of claim 76, wherein the sensor is encased in a protective covering.

85. (New) The method of claim 76, wherein the sensing step includes sensing mechanical activity of the patient through one or more layers of clothing.

86. (New) The method of claim 76, wherein the sensing step includes sensing mechanical activity of the patient through one or more layers of bedding.

87. (New) The method of claim 76, wherein the sensor comprises a plurality of said polarized polymer films arranged in an array.

88. (New) The method of claim 76, further comprising a pad with said polarized polymer film disposed therein.

89. (New) A method for passively monitoring the physiology of a patient in an environment, comprising:

coupling a first sensor with the patient;

coupling a second sensor with the patient at a location remote from the first sensor;

sensing physiological parameters of the patient and conditions of the environment around the patient with both the first and second sensors;

converting the sensed physiological parameters and environment conditions into signals;

correlating the signals from the first and second sensors; and

using the correlation to extract signals associated with the physiology of the patient.

90. (New) The method of claim 89, wherein the first and second sensors comprise passive electromechanical transducers for sensing mechanical activity of the patient's body.

91. (New) The method of claim 90, wherein the sensors comprise piezoelectric sensors.

92. (New) The method of claim 89, wherein each of the first and second sensors comprise a polarized polymer film with piezoelectric properties.

93. (New) The method of claim 90, wherein each the sensors comprise a polyvinylidene fluoride (PVDF) film.

94. (New) The method of claim 92, wherein an interface is disposed between the film and the patient for facilitating transmittal of physiological parameters from the patient to the film.

95. (New) The method of claim 93, wherein the interface is selected from the group consisting of gel, water, air, foam, rubber and plastic.

96. (New) The method of claim 89, wherein the sensing step comprises sensing noise and vibration in the environment around the patient.

97. (New) The method of claim 89, further comprising:  
placing a third sensor in a location isolated from the patient for sensing said environmental conditions without said physiological parameters of the patient;  
sensing environmental conditions with the third sensor;  
converting the sensed environmental conditions into signals; and  
reducing environmental interference in the signals produced by the first and second sensors by subtracting the signals produced by the third sensor from the signals produced by the first and second sensors.

98. (New) The method of claim 89, further comprising:  
calculating an energy spectrum from the signals; and  
extracting signals associated with the physiology of the patient by identifying peaks in the energy spectrum corresponding to physiological parameters of the patient.

99. (New) A method for passively monitoring the physiology of a patient, comprising:  
providing a plurality of sensors disposed along a patient supporting surface, each of said sensors being capable of passively sensing physiological parameters of the patient and conditions due to the environment around the patient;

sensing with each of the sensors physiological parameters of the patient and environmental conditions;

converting the sensed physiological parameters and environmental conditions into signals;

correlating the signals between the sensors; and

using the correlation to extract signals associated with the physiology of the patient.

100. (New) The method of claim 99, wherein the sensing step comprises sensing noise and vibration from the environment around the patient.

101. (New) The method of claim 99, wherein the sensing step comprises sensing mechanical activity of the patient.

102. (New) The method of claim 99, wherein the sensors comprise a plurality of polarized polymer films with piezoelectric properties disposed in an array along the patient supporting surface.

103. (New) A method for passively monitoring the physiology of a patient in a vibration environment, comprising:

coupling a plurality of independent sensors with the patient at different locations on the patient's body;

sensing mechanical activity of the patient's body due to physiology and to environmental vibration at each of said locations;

converting the sensed mechanical activity into a plurality of signals;

correlating the signals between the sensors; and

using the correlation to extract signals associated with the physiology of the patient.

104. (New) The method of claim 103, wherein the plurality of sensors comprise a plurality of polarized polymer films with piezoelectric properties.

105. (New) The method of claim 103, wherein each of the sensors comprise a polyvinylidene fluoride (PVDF) film.

106. (New) The method of claim 103, wherein the sensing step comprises sensing mechanical activity of the patient associated with cardiac and respiratory functions.

107. (New) Apparatus suitable for passively monitoring the physiology of a patient in a vibration environment, comprising:

at least two sensors, each of said sensors being capable of passively sensing physiological parameters of a patient at a different location on the patient's body and vibration from an environment around the patient;

a converter communicating with the sensors for converting the sensed physiological parameters and environmental vibration into digital signals; and

a processor communicating with the converter for processing the digital signals to extract signals associated with the physiology of the patient by correlating signals between sensors.

108. (New) The apparatus of claim 107, wherein the sensors comprise electromechanical transducers for sensing mechanical activity of the patient's body and producing electrical signals in response thereto.

109. (New) The apparatus of claim 107, wherein each of the sensors comprise a polarized polymer film with piezoelectric properties.

110. (New) The apparatus of claim 109, wherein each of the sensors comprise a polyvinylidene fluoride (PVDF) film.

111. (New) The apparatus of claim 109, further comprising a pad incorporating the polarized polymer films.

112. (New) The apparatus of claim 107, further comprising a monitor communicating with the processor for displaying the physiological data in real time.

113. (New) The apparatus of claim 107, wherein the processor is in wireless communication with the converter.

114. (New) The apparatus of claim 107, wherein the monitor is in wireless communication with the processor.

115. (New) The apparatus of claim 107, wherein the sensors are disposed along a patient supporting surface.

116. (New) The apparatus of claim 115, wherein the patient supporting surface comprises a medical transport.

117. (New) The apparatus of claim 107, wherein the sensors are disposed in hospital bedding.

118. (New) The apparatus of claim 107, further comprising an environmental sensor isolated from the patient for sensing the environmental vibration without sensing physiological parameters of the patient, said environmental sensor providing output signals corresponding to the environmental vibration, and subtracting the signals

produced by the environmental sensor from signals produced by said at least two sensors to reduce vibration interference in the signals produced by said at least two sensors.

119. (New) The apparatus of claim 107, wherein the processor further calculates an energy spectrum from the digital signals and extracts signals associated with the physiology of the patient by identifying peaks in the energy spectrum corresponding to selected physiological parameters.

120. (New) The apparatus of claim 107, further comprising a pad incorporating the sensors, and an interface within the pad formed of material selected from the group consisting of gel, water, air, foam, rubber and plastic.

121. (New) The apparatus of claim 107, wherein the processor extracts signals associated with cardiac and respiratory activity of the patient.

122. (New) Apparatus for passively monitoring the physiology of a patient, comprising:

a plurality of sensors disposed along a patient supporting surface, each of said sensors being capable of passively sensing physiological parameters of the patient at a different location on the patient's body and ambient noise and vibration due to an environment around the patient;

a converter communicating with the sensors for converting the sensed physiological parameters and ambient noise and vibration into digital signals;

a processor communicating with the converter for receiving and correlating said digital signals to extract signals associated with the physiology of the patient; and

a monitor communicating with the processor for displaying said physiological signals in real time.

123. (New) The apparatus of claim 122, wherein the sensors comprise electromechanical transducers for sensing mechanical activity of the patient's body and producing electrical signals in response thereto.

124. (New) The apparatus of claim 122, wherein each of the sensors comprise a polarized polymer film with piezoelectric properties.

125. (New) The apparatus of claim 122, wherein the patient supporting surface is selected from the group consisting of a stretcher, a bed, a litter, an operating table, a gurney, an item of furniture, a cushion, a seat and a seat back.

126. (New) The apparatus of claim 122, wherein the sensors are configured to measure pulse wave travel time between plural locations on the patient's body.

127. (New) Apparatus for passively monitoring the physiology of a patient, comprising:

a plurality of sensors for passively detecting mechanical displacements at a plurality of different locations on the patient's body;

a converter communicating with the sensors for converting the sensed displacements into a plurality of digital signals reflecting the displacements of the patient's body at each of said locations; and

a processor communicating with the converter for processing said digital signals to extract signals associated with at least one selected physiological parameter of the patient and derive an output signal representative of the selected physiological parameter, said

processor correlating the digital signals between the plurality of sensors to attenuate signals caused by ambient conditions.

128. (New) The apparatus of claim 127, wherein the sensors are configured to detect mechanical activity of the patient due to physiological conditions and vibrations from an environment around the patient.

129. (New) The apparatus of claim 127, wherein the processor processes said digital signals to extract signals associated with cardiac activity of the patient.

130. (New) The apparatus of claim 127, wherein the processor processes said digital signals to extract signals associated with respiratory activity of the patient.

131. (New) The apparatus of claim 127, wherein the processor processes said digital signals to extract signals associated with cardiac and respiratory activity of the patient.

132. (New) The apparatus of claim 127, wherein the processor correlates signals between the plurality of sensors to attenuate signals associated with environmental vibration.

133. (New) The apparatus of claim 127, wherein the plurality of sensors comprise a plurality of polarized polymer films with piezoelectric properties.

134. (New) The apparatus of claim 133, further comprising a pad incorporating the films, said pad being configured to be placed against a patient's body.

135. (New) Apparatus for passively monitoring the physiology of a patient, comprising:

a plurality of sensors for passively sensing mechanical activity at a plurality of different locations on the patient's body, at least one of said sensors being adapted to be disposed in the area of the patient's extremities;

a converter communicating with the sensors for converting the sensed mechanical activity into a plurality of digital signals; and

a processor communicating with the converter for extracting signals due to cardiac activity of the patient by selectively omitting signals from sensors remote from the patient's extremities.

136. (New) The apparatus of claim 135, wherein the at least one sensor is adapted to be disposed on the patient's foot.

137. (New) The apparatus of claim 135, wherein the plurality of sensors comprise a plurality of polarized polymer films with piezoelectric properties.

138. (New) The apparatus of claim 135, wherein the plurality of sensors comprise a plurality of polyvinylidene fluoride (PVDF) films.

139. (New) Apparatus for passively monitoring the physiology of a patient, comprising:

a plurality of sensors for sensing mechanical activity at a plurality of different locations on the patient's body;

a converter communicating with the sensors for converting the sensed mechanical activity into a plurality of digital signals; and

a processor communicating with the converter for extracting signals due to cardiac activity of the patient by selectively comparing the digital signals from said different locations on the patient's body.

140. (New) The apparatus of claim 139, wherein the plurality of sensors comprise a plurality of polarized films with piezoelectric properties.

141. (New) The apparatus of claim 139, wherein the plurality of sensors comprise a plurality of polyvinylidene fluoride (PVDF) films.

142. (New) The apparatus of claim 139, wherein the processor further transforms the digital signals into frequency signals including respiration and heart rate harmonics, and differentiates respiration and heart rate harmonics by selectively comparing signals from said different locations on the patient's body.

143. (New) A method for passively monitoring the physiology of a patient, comprising:

coupling a plurality of sensors with the patient at different locations on the patient's body, at least one of said sensors being located near the patient's extremities;  
sensing mechanical activity of the patient at each of said locations;  
converting the sensed mechanical activity into a plurality of signals; and  
extracting signals associated with cardiac activity of the patient by selectively omitting signals from sensors remote from the patient's extremities.

144. (New) The method of claim 143, wherein the at least one sensor is located at the patient's foot.

145. (New) A method for passively monitoring the physiology of a patient, comprising:

coupling a plurality of sensors with the patient at different locations on the patient's body;

sensing mechanical activity of the patient at each of said locations;

converting the sensed mechanical activity into a plurality of signals; and

extracting signals associated with cardiac activity of the patient by selectively comparing the signals from said different locations on the patient's body.

146. (New) The method of claim 145, further comprising transforming the signals into frequency signals including respiration and heart rate harmonics, and differentiating respiration and heart rate harmonics by selectively comparing signals from different locations on the patient's body.

147. (New) Apparatus for passively monitoring the physiology of a patient, comprising:

at least two sensors, each sensor comprising a polarized polymer film with piezoelectric properties, for sensing physiological parameters of the patient at different parts of the patient's body;

a converter communicating with the sensors for converting the sensed physiological parameters into digital signals; and

a processor communicating with the converter for determining pulse wave velocity in response to the time difference between corresponding signals from the sensors and for converting the pulse wave velocity into signals corresponding to blood pressure data.

148. (New) The apparatus of claim 147, wherein the at least two sensors comprise a first sensor disposed at a first location along a patient supporting surface and a second sensor disposed at a second location along the patient supporting surface remote from the first location.

149. (New) The apparatus of claim 147, wherein the processor converts the pulse wave velocity into signals corresponding to systolic and diastolic blood pressure data.

150. (New) The apparatus of claim 147, wherein the at least two sensors comprise at least three sensors for sensing physiological parameters of the patient at at least three different parts of the patient's body, and the processor determines pulse wave velocity in response to the time difference between signals from the at least three sensors.

151. (New) Apparatus for passively monitoring the physiology of a patient, comprising:

at least two sensors, each sensor comprising a polarized polymer film with piezoelectric properties, for sensing physiological parameters of the patient at different parts of the patient's body;

a converter communicating with the sensors for converting the sensed physiological parameters into digital signals; and

a processor communicating with the converter for determining pulse wave travel time in response to the time difference between corresponding signals from the sensors and for converting the pulse wave travel time into signals corresponding to blood pressure data.

152. (New) The apparatus of claim 151, wherein the at least two sensors comprise a first sensor disposed at a first location along a patient supporting surface and a second sensor disposed at a second location along the patient supporting surface remote from the first location.

153. (New) The apparatus of claim 151, wherein the processor converts the pulse wave travel time into signals corresponding to systolic and diastolic blood pressure data.

154. (New) The apparatus of claim 151, wherein the at least two sensors comprise at least three sensors for sensing physiological parameters of the patient at at least three different parts of the patient's body, and the processor determines pulse wave travel time in response to the time difference between signals from the at least three sensors.

155. (New) Apparatus for passively monitoring the physiology of a patient, comprising:

a plurality of sensors for sensing physiological parameters of the patient at at least three different locations on the patient's body;

a converter communicating with sensors for converting the sensed physiological parameters into a plurality of digital signals corresponding to the sensed physiological parameters at each of said sensors; and

a processor communicating with the converter for extracting signals representative of the heart rate of the patient at each of said different locations on the patient's body, comparing the heart rate signals from the different locations on the patient's body to

determine the temporal separation between corresponding heart rate signals at said different locations on the patient's body, calculating the rate of pulse wave propagation through the patient's body based on said temporal separation, and converting the rate of pulse wave propagation into signals corresponding to blood pressure data.

156. (New) The apparatus of claim 155, wherein each of the sensors comprises a polarized polymer film with piezoelectric properties.

157. (New) The apparatus of claim 155, wherein the plurality of sensors comprise a plurality of polyvinylidene fluoride (PVDF) films.

158. (New) The apparatus of claim 155, wherein the blood pressure signals comprise systolic and diastolic blood pressure data.

159. (New) A method for passively monitoring the physiology of a patient, comprising:

coupling a first sensor with the patient at a first part of a patient's body;

coupling a second sensor with the patient at a different part of a patient's body,

each of the first and second sensors comprising a polarized polymer film with piezoelectric properties;

sensing physiological activity of the patient with both the first and second sensors;

converting the sensed physiological activity into signals;

measuring pulse wave velocity with the first and second sensors; and

converting the pulse wave velocity into blood pressure data.

160. (New) The method of claim 159, wherein the pulse wave velocity is converted into systolic and diastolic blood pressure data.

161. (New) The method of claim 159, further comprising coupling a third sensor with the patient at a third part of the patient's body, said third sensor comprising a polarized polymer film with piezoelectric properties;

sensing physiological activity of the patient with third sensor; and

measuring pulse wave velocity in response to the time difference between corresponding signals from the first, second and third sensors.

162. (New) A method for passively monitoring the physiology of a patient, comprising:

coupling a first sensor with the patient at a first part of the patient's body;

coupling a second sensor with the patient at a different part of the patient's body,

each of the first and second sensors comprising a polarized polymer film with piezoelectric properties;

sensing physiological activity of the patient with both the first and second sensors;

converting the sensed physiological activity into signals;

measuring pulse wave travel time between the first and second sensors; and

converting the pulse wave travel time into blood pressure data.

163. (New) The method of claim 162, wherein the pulse wave travel time is converted into systolic and diastolic blood pressure data.

164. (New) The method of claim 162, further comprising coupling a third sensor with the patient at a third part of the patient's body, said third sensor comprising a polarized polymer film with piezoelectric properties;

sensing physiological activity of the patient with the third sensor; and

measuring pulse wave travel time in response to the time difference between corresponding signals from the first, second and third sensors.

165. (New) A method for passively monitoring the physiology of a patient, comprising:

coupling a first sensor with the patient at a first location on the patient's body;  
coupling a second sensor with the patient at a second location on the patient's body;

coupling a third sensor with the patient at a third location on the patient's body;  
sensing physiological activity of the patient with the first, second and third sensors;

converting the sensed physiological activity into signals;

measuring pulse wave travel time between the first, second and third sensors; and  
converting the pulse wave travel time into blood pressure data.

166. (New) The method of claim 165, wherein the blood pressure data comprises systolic and diastolic blood pressure data.

167. (New) The method of claim 165, wherein the second location is remote from the first location, and the third location is remote from the first and second locations.

168. (New) The method of claim 165, wherein the sensing step comprises sensing physiological activity through one or more layers of clothing.

169. (New) The method of claim 165, wherein the sensing step comprises sensing physiological activity through one or more layers of bedding.

170. (New) A method for passively monitoring the physiology of a patient, comprising:

coupling a first sensor with the patient at a first location on the patient's body;  
coupling a second sensor with the patient at a second location on the patient's body;  
coupling a third sensor with the patient at a third location on the patient's body;  
sensing physiological activity of the patient with the first, second and third sensors;  
converting the sensed physiological activity into signals;  
measuring pulse wave velocity with the first, second and third sensors; and  
converting the pulse wave velocity into blood pressure data.

171. (New) The method of claim 170, wherein the blood pressure data comprises systolic and diastolic blood pressure data.

172. (New) The method of claim 170, wherein the second location is remote from the first location and the third location is remote from the first and second locations.

173. (New) The method of claim 170, wherein the sensing step comprises sensing physiological activity through one or more layers of clothing.

174. (New) The method of claim 170, wherein the sensing step comprises sensing physiological activity through one or more layers of bedding.

175. (New) A method for passively monitoring the physiology of a moving patient, comprising:

coupling a first sensor with the patient;

coupling a second sensor with the patient at a location remote from the first sensor;

sensing mechanical activity of the patient due to physiological parameters and to extraneous movement of the patient's body with both the first and second sensors;

converting the sensed mechanical activity into signals;

correlating the signals between the first and second sensors; and

using the correlation to differentiate between signals due to physiological parameters and signals due to extraneous movement.

176. (New) The method of claim 174, wherein each of the sensors comprise a polarized polymer film with piezoelectric properties.

177. (New) The method of claim 174, wherein the sensing step comprising sensing mechanical activity of the patient due to heartbeat and respiration.

178. (New) The method of claim 174, wherein the sensors are disposed along a patient supporting surface.

179. (New) Apparatus for passively monitoring the physiology of a moving patient, comprising:

at least two sensors, each of said sensors being configured for sensing mechanical activity of a patient due to physiological parameters and to extraneous movement at a different location on the patient's body;

a converter communicating with the sensors for converting the sensed mechanical activity into digital signals; and

a processor communicating with the converter for processing said digital signals to differentiate between signals due to physiological parameters and signals due to extraneous movement by correlating the signals between the sensors.

180. (New) The apparatus of claim 179, wherein each of the sensors comprise a polarized polymer film with piezoelectric properties.

181. (New) The apparatus of claim 179, wherein each of the sensors comprise a polyvinylidene fluoride (PVDF) film.

182. (New) The apparatus of claim 179, wherein the sensors are disposed along a patient supporting surface.

183. (New) The apparatus of claim 179, further comprising a pad incorporating the sensors.

184. (New) A method for passively monitoring the physiology of a patient in a helicopter environment, comprising:

coupling a motion sensor with the patient;

sensing mechanical activity of the patient with the sensor, including activity associated with the physiology of the patient and activity associated with the helicopter environment;

converting the sensed mechanical activity into signals;

extracting signals corresponding to the physiology of the patient;

separating signals associated with a selected physiological parameter of the patient; and

outputting a signal representative of the selected physiological parameter of the patient.

185. (New) The method of claim 184, wherein the sensor comprises a polarized polymer film with piezoelectric properties.

186. (New) The method of claim 184, further comprising coupling a plurality of sensors with the patient at different locations on the patient's body, and sensing mechanical activity of the patient with said sensors.

187. (New) A method for passively monitoring the physiology of a patient, comprising:

coupling a first sensor with the patient;

coupling a second sensor with the patient at a location remote from the first sensor;

sensing physiological signals and environmental noise and vibration with the first and second sensors;

comparing the physiological signals and environmental noise and vibration from the first sensor with the physiological signals and environmental noise and vibration from the second sensor to determine locations of the first and second sensors on the patient; and

isolating selected physiological signals from the environmental and noise vibration.